Instructions: Complete each of the following exercises.

Three-Dimensional Coordinate Systems

1. Find the equation of the sphere centered at the point $(1, 2, 3)$ and which passes through the origin.
2. Find the side lengths of $\triangle PQR$; classify as right, isosceles, equilateral, or none of these.

   (a) $P = (3, -2, -3),\ Q = (7, 0, 1),\ R = (1, 2, 1)$

   (b) $P = (2, -1, 0),\ Q = (4, 1, 1),\ R = (4, -5, 4)$

3. Determine whether the points below lie on a straight line.

   (a) $A = (2, 4, 2),\ B = (3, 7, -2),\ C = (1, 3, 3)$

   (b) $A = (0, -5, 5),\ B = (1, -2, 4),\ C = (3, 4, 2)$

4. Show that the equation below represents a sphere, and find its center and radius.

   (a) $x^2 + y^2 + z^2 - 2x - 4y + 8z = 15$

   (b) $3x^2 + 3y^2 + 3z^2 = 10 + 6y + 12z$

5. Write inequalities to describe the region below.
   (a) The region between the yz-plane and the vertical plane $x = 5$.
   (b) The cylinder on or below plane $z = 8$ and on or above the disk about the origin of radius 2 in the xy-plane.
   (c) All points between but not on the spheres of radius r and R centered at the origin, where $r < R$.
   (d) The solid upper hemisphere of the sphere of radius 2 centered at the origin.